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Green Infrastructure benefits of tree trenches and tree boxes

Tree trenches and tree boxes (https://stormwater.pca.state.mn.us/index.php?title=Trees) are a specific type of **bioretention practice**. They are vegetated engineered landscape practices designed to filter or infiltrate stormwater runoff. They can be incorporated into a wide variety of landscaped areas, including **highly urban and ultra-urban environments** landscapes. While tree boxes and tree trenches are bioretention practices, but their design, construction, maintenance, and benefits merit a separate discussion.

While the focus of this page is on a specific practice designed to treat and reduce stormwater runoff, urban forestry is discussed where appropriate. Urban forestry includes all trees collectively in a specific urban area.

Check it out

See this recent article on The Significance of the Urban Forest in the Urban Environment (https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=43772#:~:text=The%20existence%20of%20trees%20and,thereby%20creating%20healthier%2C%20safer%20communities.).

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Green infrastructure and multiple benefits

Green infrastructure (GI) encompasses a wide array of practices, including stormwater management. **Green stormwater infrastructure** (GSI) encompasses a variety of practices primarily designed for managing stormwater runoff but that provide additional benefits such as habitat or aesthetic value.

There is no universal definition of GI or GSI (link here fore more information (https://stormwater.pca.state.mn.us/index.php?title=Green_infrastructure_and_green_stormwater_infrastructure_terminology)). Consequently, the terms are often interchanged, leading to confusion and misinterpretation. GSI practices are designed to function as stormwater practices first (e.g. flood control, treatment of runoff, volume control), but they can provide additional benefits. Though designed for stormwater function, GSI practices, where appropriate, should be designed to deliver multiple benefits (often termed "multiple stacked benefits". For more information on green infrastructure, ecosystem services, and sustainability, link to Multiple benefits of green infrastructure and role of green infrastructure in sustainability and ecosystem services.

Green Infrastructure benefits of tree trenches and tree boxes

Benefit	Effectiveness	Notes
Water quality	●	Benefits are maximized for bioinfiltration. Biofiltration may export phosphorus if not designed properly.
Water quantity/supply	◕	Bioinfiltration helps mimic natural hydrology. Some rate control benefit.
Energy savings	◕	
Climate resiliency	●	Provides some rate control. Impacts on carbon sequestration are uncertain.
Air quality	◕	
Habitat improvement	◕	Use of perennial vegetation and certain media mixes promote invertebrate communities.
Community livability	●	Aesthetically pleasing and can be incorporated into a wide range of land use settings.
Health benefits	◕	
Economic savings	◔	Generally provide cost savings vs. conventional practices over the life of the practice.
Macroscale benefits	◑	Individual practices are typically microscale, but multiple practices, when incorporated into a landscape design, provide macroscale benefits such as wildlife corridors.
Level of benefit: ○ - none; ◔; - small; ◑ - moderate; ◕ - large; ● - very high		

Because of their diversity and use of vegetation, tree trench and tree box practices provide multiple green infrastructure benefits.

Information: For a list of trees with specific benefits see Appendix A in Nowak and Heisler, 2010 (citation in Reference section of this page).

- **Water quality** (https://stormwater.pca.state.mn.us/index.php?title=Water_quality_benefits_of_Green_Stormwater_Infrastructure): Tree trenches and tree boxes are an excellent stormwater treatment practice due to the variety of pollutant removal mechanisms including vegetative **filtering** (https://stormwater.pca.state.mn.us/index.php?title=Filtration), settling, evaporation, **infiltration** (https://stormwater.pca.state.mn.us/index.php?title=Stormwater_infiltration_Best_Management_Practices), **transpiration**, biological and microbiological uptake, and soil adsorption. Tree trenches and tree boxes can be designed as an effective infiltration / recharge practice, particularly when parent soils have high permeability (> ~ 0.5 inches per hour). Link to water quality information for tree trench/tree box - [1] (https://stormwater.pca.state.mn.us/index.php?title=Calculating_credits_for_tree_trenches_and_tree_boxes)
- **Water quantity/supply** (https://stormwater.pca.state.mn.us/index.php?title=Water_quantity_and_hydrology_benefits_of_Green_Stormwater_Infrastructure): Tree trenches and tree boxes can be designed as an effective infiltration / recharge practice when parent soils have high permeability. Large tree trench systems

can be incorporated into ultra-urban settings and provide significant volume control. For lower permeability soils an **underdrain** is typically used and some infiltration and rate control can be achieved.

- **Energy savings**: Urban trees can reduce energy needs as a result of heat mitigation associated with reduction in impervious surface, cooling associated with **evapotranspiration**, and shading. McPherson and Simpson (2003) estimated existing trees are projected to reduce annual air conditioning energy use by 2.5% with a wholesale value of $ 485.8 million. Peak load reduction by existing trees saves utilities 10% valued at approximately $778.5 million annually, or $4.39/tree. Other researchers have documented reduced energy consumption associated with urban trees ([2] (https://escholarship.org/content/qt4qs5f42s/qt4qs5f42s.pdf), [3] (https://www.sciencedirect.com/science/article/pii/S037877880900005X), [4] (https://trees-energy-conservation.extension.org/urban-trees-energy-conservation/)).
- **Climate resiliency** (https://stormwater.pca.state.mn.us/index.php?title=Climate_benefits_of_Green_Stormwater_Infrastructure): Properly installed and maintained trees provide significant benefits for climate resiliency. The primary benefit is through carbon **sequestration**. A mature tree typically sequesters about 50 pounds of carbon per year, depending on species, tree health, and tree growth rate (U.S. Department of Energy, Energy Information Administration, 1998) (https://www3.epa.gov/climatechange/Downloads/method-calculating-carbon-sequestration-trees-urban-and-suburban-settings.pdf). Nowak and Crane (https://www.nrs.fs.fed.us/pubs/jrnl/2002/ne_2002_nowak_002.pdf) (2002) estimated that urban forests store about 700 million tonnes of carbon. Although carbon storage per unit area was only about half that in forested areas, urban forests grow quickly and trees reach maturity sooner compared to natural forests.
- **Air quality** (https://stormwater.pca.state.mn.us/index.php?title=Air_quality_benefits_of_Green_Stormwater_Infrastructure): Trees impact air quality through temperature reduction and removal of air pollutants, including carbon sequestration. Trees release **volatile organic compounds** (VOCs) that may contribute to formation of ozone and carbon monoxide. However, because trees can lower air temperatures, they may contribute to overall reductions in VOC emissions and thus ozone formation. Nowak cited data suggesting that 100 percent tree coverage in an urban area reduces criteria pollutants by 8-15 percent, depending on the pollutant and local environmental conditions ([5] (https://www.fs.usda.gov/treesearch/pubs/52881), [6] (https://escholarship.org/content/qt4qs5f42s/qt4qs5f42s.pdf), [7] (https://www.nrs.fs.fed.us/units/urban/local-resources/downloads/Tree_Air_Qual.pdf)).
- **Habitat improvement** (https://stormwater.pca.state.mn.us/index.php?title=Wildlife_habitat_and_biodiversity_benefits_of_Green_Stormwater_Infrastructure): Individual trees can provide microhabitats such as cavities, bark pockets, large dead branches, epiphytes, cracks, sap runs, or trunk rot that can be utilized by a variety of animals, plants, and fungi. Animal species use trees for shelter and food and include birds, small mammals, amphibians and reptiles, arachnids, and insects. Plants, lichens, and fungi can use trees as growing substrates or as a food source. Collectively, trees can be designed to act as corridors or small patches which can be utilized by a variety of animal species. Unlike forested ecosystems, urban trees and urban forests lack certain attributes, such as dead snags that offer shelter (Miller (https://ufi.ca.uky.edu/wildlife-habitat-tree) (accessed July 6, 2022); Sundberg (https://www.ecolandscaping.org/02/designing-ecological-landscapes/trees/the-birds-and-the-trees-managing-the-urban-forest-for-wildlife/), 2019).
- **Community livability** (https://stormwater.pca.state.mn.us/index.php?title=Social_benefits_of_Green_Stormwater_Infrastructure): Trees are an aesthetically pleasing practice and have been shown to have positive effects on community perceptions. Trees can be incorporated into recreational areas and provide associated benefits (shading, habitat). As discussed in this section, trees provide health, economic, and environmental benefits. Trees can be difficult to incorporate into some urban landscapes due to space or other constraints (e.g. utilities) ([8] (https://nph.onlinelibrary.wiley.com/doi/full/10.1002/ppp3.39), [9] (https://www.mdpi.com/2073-445X/7/4/161)).
- **Health benefits** (https://stormwater.pca.state.mn.us/index.php?title=Social_benefits_of_Green_Stormwater_Infrastructure): Health benefits of trees are well documented and include but are not limited to sequestration of harmful air pollutants (e.g. particulates), mitigation of summer heat stress, improved mental health and reduced stress, reduction in exposure to UV radiation, and positive clinical health (References: [10] (https://www.nature.org/content/dam/tnc/nature/en/documents/Public_Health_Benefits_Urban_Trees_FINAL.pdf), [11] (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7345658/), [12] (https://www.frontiersin.org/articles/10.3389/fevo.2021.603757/full)). Green spaces may also improve mental and physical health for residents and reduce crime (Barton and Rogerson, 2017). Studies suggest, however, that health benefits of trees may be

limited to adaptive rather than mitigative effects, primarily due to limitations in space and structure of urban forests.

- **Economic benefits and savings** (https://stormwater.pca.state.mn.us/index.php?title=Economic_benefits_of_Green_Stormwater_Infrastructure): Benefits of trees discussed above provide economic value, for example, in the form of reduced cost of water quality or quantity treatment, improved health, recreation, and energy savings. Additional economic benefits include increased property values, job creation, and positive consumer outcomes. Several studies have attempted to quantify economic benefits of trees, with a wide range of results, but estimates are typically in the tens of billions of dollars (References: [13] (https://conservationtools.org/conservation-benefits/131-Economic-Benefits-of-Urban-Trees-and-Green-Infrastructure), [14] (https://www.sausalitobeautiful.org/economic-value-of-urban-trees/), [15] (https://www.arborday.org/urban-forestry-economic/), [16] (https://www.frontiersin.org/articles/10.3389/fevo.2020.00016/full#:~:text=Trees%20in%20urban%20areas%20have,pollutant%20formation%20in%20the%20atmosphere.)).
- **Macroscale benefits**: Trees incorporated into stormwater management systems, such as tree trenches and boxes, typically have local rather than macroscale impacts. Macroscale benefits are realized at the urban forest level, which includes all trees in an urban area. Some studies have assessed the relationship between canopy cover and a specific benefit, such as carbon sequestration, stormwater runoff reduction, and health impacts ([17] (https://www.pnas.org/doi/10.1073/pnas.1817561116), [18] (https://www.cwp.org/urban-tree-canopy/)). Models can be used to extrapolate individual tree effects to a macroscale. Studies generally show that increasing urban forest connectivity and canopy cover in appropriate areas provides increased benefits at the macroscale ([19] (http://usir.salford.ac.uk/id/eprint/36119/), [20] (https://www.sciencedirect.com/science/article/pii/S0169204621001407))

Design considerations

Photo of the completed tree system for the Central Corridor Light Rail Transit project, St. Paul, Minnesota. Image courtesy of the Capitol Region Watershed District (http://www.capitolregionwd.org/).

Tree trenches and tree boxes are bioretention practices. Therefore, design considerations to enhance green infrastructure benefits of tree trenches and tree boxes are similar to design considerations for bioretention (https://stormwater.pca.state.mn.us/index.php?title=Green_Infrastructure_benefits_of_bioretention#Design_considerations).

Maximizing specific green infrastructure (GI) benefits requires design considerations prior to constructing the practice. This includes operation and maintenance (O&M) considerations in the design phase. See the supplemental reading list (https://stormwater.pca.state.mn.us/index.php?title=Green_Infrastructure_benefits_of_tree_trenches_and_tree_boxes#Recommended_reading) for more information on design, construction, and O&M. While site limitations cannot always be overcome, the following recommendations maximize the GI benefit of bioretention.

- Water quality
  - Maximize infiltration by designing with the maximum ponded depth that can be infiltrated in 48 hours, up to 1.5 feet (to protect vegetation). Where space allows, surface area can also be increased.
  - Utilize multiple bioretention practices in series.
  - On lower permeability soils where an underdrain is used, raise the underdrain to the maximum extent possible, allowing water stored in the **engineered media** (https://stormwater.pca.state.mn.us/index.php?title=Design_criteria_for_bioretention#Materials_specifications_-_filter_media) below the underdrain to drain in 48 hours. Use an upturned elbow in underdrained systems.
  - For **bioinfiltration** (bioretention without an underdrain), use a high organic matter media to maximize pollutant removal.

  - For **biofiltration** (https://stormwater.pca.state.mn.us/index.php?title=Bioretention) (bioretention with an underdrain), use a media mix that does not export phosphorus (https://stormwater.pca.state.mn.us/index.php?title=Design_criteria_for_bioretention#Addressing_phosphorus_leaching_concerns_with_media_mixes) or use an amendment to attenuate phosphorus (https://stormwater.pca.state.mn.us/index.php?title=Soil_amendments_to_enhance_phosphorus_sorption).
- Water quantity/supply
  - Maximize infiltration
  - Utilize internal water storage (http://chesapeakestormwater.net/wp-content/uploads/downloads/2014/03/Internal-Water-Storage-for-Bioretention-2009.pdf)
  - Maximize water storage in media
- Energy ([21] (https://treescharlotte.org/tree-education/trees-save-energy/), [22] (https://trees-energy-conservation.extension.org/time-for-trees-to-provide-energy-conservation-benefits/), [23] (https://www.firstenergycorp.com/help/saving_energy/trees.html), [24] (https://www.sciencedirect.com/science/article/pii/S0169204616302122))
  - Select trees based on objectives (e.g. quick-growing or slow-growing, deciduous or coniferous, large or small canopy).
  - Plant deciduous trees to shade sun in summer but allow sun to pass through in the winter.
  - Select a tree that can be planted within twenty feet of windows and that will grow at least ten feet taller than the window(s). When space permits, use as many trees as needed to create a continuous planting.
  - Shade all hard surfaces such as driveways, patios and sidewalks to minimize landscape heat load.
  - Place coniferous trees to intercept and slow winter winds, usually on the north side of the building. Do not plant them on the south or west side because this blocks warming sunlight during the winter. These trees also provide some shading benefits during summer.
  - Plan on pruning trees to maximize summer shading and to allow sun to enter in the winter.
  - Plant trees to shade air conditioners but allow air circulation.
  - Use trees as windbreaks, typically on the north and northwest side of the building. Plant your windbreak at a distance from the building of two to five times the mature height of the trees.
- Climate resiliency
  - Select species that are more likely to survive in the anticipated future climate.
  - Select species that efficiently sequester carbon.
  - Ensure trees receive adequate water.
  - To reduce heat island effects, select vegetation that reflects solar energy, absorbs solar energy and releases it slowly, or that maximizes evapotranspiration NYC Mayor’s Office of Recovery and Resiliency (http://www1.nyc.gov/assets/orr/images/content/header/ORR_ClimateResiliencyDesignGuidelines_PRELIMINARY_4_21_2017.pdf)
  - Oversize storage area to account for increased precipitation. Winston (2016) recommends oversizing by 33-45% for bioretention in northern Ohio. Oversizing can also be accomplished by reducing loading to individual bioretention practices. ([25] (http://www.hort.cornell.edu/uhi/research/articles/Maple%20paper.pdf), [26] (https://academic.oup.com/forestry/article/88/1/13/2756020), [27] (http://www.righttrees4cc.org.uk/), [28] (https://mortonarb.org/science/projects/regional-forestry-data-set/), [29] (https://www.fs.usda.gov/ccrc/topics/urban-forests-and-climate-change), [30] (https://toolkit.climate.gov/case-studies/fortifying-chicagos-urban-forest))
- Air quality ([31] (https://www.fs.fed.us/nrs/pubs/jrnl/2010/nrs_2010_nowak_002.pdf), [32] (https://www.nrs.fs.fed.us/units/urban/local-resources/downloads/Tree_Air_Qual.pdf))
  - Park designs that include a variety of land cover—areas of dense trees, scattered trees, and lawn—are likely to provide the greatest opportunities for optimum physical comfort of visitors.
  - Increase the number of healthy trees (increases pollution removal)
  - Sustain existing tree cover (maintains pollution removal levels)
  - Maximize use of low VOC emitting trees (reduces ozone and carbon monoxide formation)
  - Sustain large, healthy trees (large trees have the greatest per tree effects)
  - Use long-lived trees (reduces long-term pollutant emissions from planting and removal)
  - Use low maintenance trees (reduces pollutant emissions from maintenance activities)
  - Reduce fossil fuel use in maintaining vegetation (reduces pollutant emissions)

  - Plant trees in energy conserving locations (reduces pollutant emissions from power plants)
  - Plant trees to shade parked cars (reduces vehicular VOC emissions)
- Habitat
  - Utilize native, perennial vegetation, including shrubs and trees if space allows. Select trees for specific habitat characteristics. For more information, see Minnesota plant lists (https://stormwater.pca.state.mn.us/index.php?title=Minnesota_plant_lists#Plants_for_Stormwater_Design) and (Miller (https://ufi.ca.uky.edu/wildlife-habitat-tree) (accessed July 6, 2022)).
  - Incorporate landscape features, such as form, plant layering, and plant density. For more information on landscape factors, see this presentation (https://scisoc.confex.com/scisoc/2015am/webprogram/Paper91320.html) by Dr. Steven Rodie (University of Nebraska at Omaha).
  - Maximize leaf/plant litter depth and the number of plant taxa.
  - Consider shape and size to create larger interior habitats.
  - Evaluate adjacent plant communities for compatibility with proposed bioretention area species. Identify nearby vegetated areas that are dominated by nonnative invasive species.
  - Promote soil (media) that maximizes habitat for invertebrate. This includes adjusting pH, limiting the amount of gravel, and promoting development of organic matter. See Kazemi et al. (http://www.sciencedirect.com/science/article/pii/S0169204609001029) (2009) for more information.
  - Design tree networks for connectivity, which creates corridors for wildlife, and patches, which mimic small forested areas (Mortberg and Wallentinus (https://www.researchgate.net/publication/223470552_Red-listed_forest_bird_species_in_an_urban_environment_-_Assessment_of_green_space_corridors), 2000).

Caution: Biofiltration practices (bioretention with an underdrain) may export phosphorus. Select an appropriate mix or add amendments that attenuate phosphorus to the design.

26 year old trees in the Tryon Street Mall. Image Courtesy of The Kestrel Design Group, Inc.

- Community livability
  - Choose locations for bioretention that enhance aesthetics.
  - Choose vegetation that mimics a native landscape, such as tall grass prairie or mixed woodland.
  - Evaluate the best placement of vegetation within the bioretention area. Place plants at irregular intervals to replicate a natural setting. Trees should be placed on the perimeter of the area to provide shade and shelter from the wind. Trees and shrubs can be sheltered from damaging flows if they are placed away from the path of the incoming runoff. In cold climates, species that are more tolerant to cold winds, such as evergreens, should be placed in windier areas of the site.
- Health benefits
  - Choose locations for bioretention that enhance aesthetics.
  - Perennial vegetation, particularly shrubs and trees, provide health benefits related to filtering air pollutants (https://stormwater.pca.state.mn.us/index.php?title=Air_quality_benefits_of_Green_Stormwater_Infrastructure). See The Health Benefits of Trees (https://www.theatlantic.com/health/archive/2014/07/trees-good/375129/) (Hamblin, 2014).
- Economic benefits
  - Choose the correct BMP. There is no comprehensive guidance on this, but an important factor in selecting BMPs is cost per unit treatment. This depends on the goal of the project, but examples of costs may be dollars per cubic foot of water treated or per pound of pollutant. Barr Engineering completed a report (https://www.pca.state.mn.us/sites/default/files/p-gen3-13x.pdf) that provides information on construction costs, maintenance costs, and land requirements for several stormwater BMPs. The report includes references to other useful reports. Information in the report can be used to match the site goals (e.g. infiltration vs. filtration) and site conditions (e.g. large vs. small site) to the most cost-efficient BMP.

- Factor in all benefits in evaluating the economic value of a BMP or multiple GI practices. For example, appropriate implementation of GI practices can enhance property values. Proper selection of vegetation provides energy savings. Utilizing captured rainwater as an indoor non-potable water source provides savings on energy and water use.
- Utilize multiple properly placed BMPs that work together. For example, **permeable pavement (https://stormwater.pca.state.mn.us/index.php?title=Permeable_pavement)** can be integrated with tree trenches and tree boxes to provide an aesthetically pleasing landscape that increases the value of the property while increasing the efficiency of stormwater treatment.

Tree ordinances

A tree ordinance is a tool to help protect and manage a community's trees. It can be designed to regulate various aspects of tree planting, removal, and maintenance on public and private property within a municipality. For more general information on tree ordinances, link here: [33] (http://conservationtools.org/guides/37-tree-ordinance/), [34] (https://content.ces.ncsu.edu/developing-successful-tree-ordinances), or [35] (https://www.isa-arbor.com/Credentials/Types-of-Credentials/ISA-Certified-Arborist-Municipal-Specialist/Tree-Ordinance-Guidelines).

The urban forest provides a wide variety of benefits. Increasingly, ordinances and master plans are being developed to protect and enhance the urban forest.

- City of Maplewood, Minnesota (http://www.ci.maplewood.mn.us/1076/Tree-Ordinances)
- Lancaster, Pennsylvania (https://cityoflancasterpa.com/tree-ordinance-manual/)
- Dallas, Texas (http://dallascityhall.com/departments/sustainabledevelopment/planning/Documents/ARTICLE%20X_Orig_Format.pdf)
- Arbor Day Foundation
  - Sample city tree ordinance (https://www.arborday.org/programs/treecityusa/graphics/sample-tree-ordinance.pdf)
  - Sample municipal tree ordinance (https://www.arborday.org/programs/treecityusa/documents/sample-tree-ordinance-with-tree-board-2021-annotated.pdf)
  - Sample municipal tree ordinance (https://www.arborday.org/programs/treecityusa/documents/sample-tree-ordinance-with-tree-board.pdf)
  - Sample municipal tree ordinance (https://www.arborday.org/programs/treecityusa/documents/sample-tree-ordinance-without-tree-board-2021-updated.pdf)
  - How to Write a Municipal Tree Ordinance (https://www.arborday.org/trees/bulletins/coordinators/resources/pdfs/009.pdf)
- Ordinance on vegetation and disease control (https://stormwater.pca.state.mn.us/index.php?title=File:2355-08_signed_copy_of_new_Tree_Ordinance.pdf) - City of St. Louis Park
- Ordinance on vegetation and disease control (https://www.hayfieldmn.com/vertical/sites/%7BEDA39A84-9CE5-47D2-87C1-1ECE14F2631F%7D/uploads/Chapter_5_-_Section_5_-_Shade_Tree_Pest_Control.pdf) - City of Hayfield
- Model landscape ordinance (https://stormwater.pca.state.mn.us/index.php?title=File:Model_Landscape_Ordinance.docx)

Urban forest management master plans

An urban forest master plan provides a road map for managing trees and the tree canopy in an urban area. The master plan typically includes detailed information, recommendations, and resources needed to manage an urban forest. An important component of a good forest master plan is engaging citizens and other stakeholders in the value and care of the urban forest.

A master plan may contain some or all of the following elements.

- Need and authorization, such as the need for ordinances
- Background information, such as historical and current condition of urban forest
- Public participation process
- Urban forest functions and benefits
- Urban forest vision
- Urban forest goals and objectives
- Implementation strategies
- Implementation and phasing
- Monitoring and protection strategy
- Limitations

Example master plans are found at the following links.

- Pittsburgh, Pennsylvania (https://www.treepittsburgh.org/resource/pittsburgh-urban-forest-master-plan/)
- Palo Alto, California (https://www.cityofpaloalto.org/Departments/Public-Works/Public-Services/Palo-Altos-Urban-Forest/Urban-Forest-Master-Plan)
- DeWitt, New York (http://nysufc.org/category/urban-forest-master-plans/)
- SanFrancisco, California (http://sf-planning.org/urban-forest-plan)
- Missoula, Montana (https://www.ci.missoula.mt.us/DocumentCenter/View/31003)

Recommended reading

- Stormwater to Street Trees (https://www.epa.gov/sites/production/files/2015-11/documents/stormwater2streettrees.pdf). US EPA 841-B-13-001September 2013.
- Design guidelines for tree quality and planting - tree trenches and tree boxes
- Design guidelines for soil characteristics - tree trenches and tree boxes
- Construction guidelines for tree trenches and tree boxes
- Protection of existing trees on construction sites
- Operation and maintenance (O&M) of tree trenches and tree boxes
- Operation and maintenance of tree trenches and tree boxes - supplemental information

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